Calculations of fission properties using microscopic models for astrophysics applications

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Nuclear fission could play a crucial role in the r-process nucleosynthesis under certain hydrodynamical conditions. If under these conditions the nucleosynthesis reaches the transuranium region, then fission will prohibit the synthesis of the superheavy elements. Neutron-induced and beta-delayed fission in particular, in astrophysical environments where the neutron densities are sufficiently large to produce fissile nuclei may strongly influence the abundances in the lower mass region through the re-cycling of the r-process material, while spontaneous fission will affect the final abundance pattern, especially the production of long-lived radiocosmochronometers Th and U. Of course all of these fission processes involve extremely neutron-rich nuclei that are unable to be measured in the laboratory. It is therefore of paramount importance to make reliable predictions of the relevant beta-delayed and neutron-induced fission rates, as well as the spontaneous fission half-lives, of all these unknown nuclides, starting from relatively close to the stability line and going out towards the drip line. In this respect, an attempt has been made to treat all aspects of fission on a microscopic basis, using a Skyrme-Hartree-Fock approach for the calculation of masses, fission barriers and fission level densities.

We present the results of the analysis of the potential energy surfaces obtained with a Skyrme-Hartree-Fock-Bogoliubov method in a multidimensional deformation space. Both *static* and *dynamic* fission paths are calculated and the corresponding spontaneous fission half-lives are compared with experimental data. The barrier heights and widths along the *static* paths are also used to calculate the fission transmission coefficients within the Hill-Wheeler theory. The latter are then used to obtain neutron-induced fission cross sections within the framework of the Hauser-Feshbach theory. Corrections for subbarrier effects are taken into account. Apart from the fission barriers, nuclear level densities at ground-state and saddle-point deformations are also important quantities in the calculations of neutron-induced fission cross sections. In our approach they are obtained from microscopic statistical calculations based on a constrained Skyrme-Hartree-Fock description of the nucleus. The results of our calculations are first compared with existing experimental data in the actinide region. Several improvements, in particular on the nuclear level densities are discussed. Finally, large-scale calculations of fission haf-lives and neutron-induced fission cross sections, as well as the impact on r-process nucleosynthesis, are presented.

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